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(54) ATTITUDE-CONTROLLING SYSTEM AND A MISSILE EQUIPPED WITH SUCH A SYSTEM

(71) We, THOMSON-BRANDT, a French Body Corporate, of 173 Boulevard Haussmann, 75008, Paris, France, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to missiles having a system for controlling the roll attitude of the missile body.

Throughout the text, the term "missile" is to be understood in its generic sense, which covers, inter alia, projectiles, rockets and propelled or unpropelled missiles whose trajectory may or may not be controlled.

When a missile is moving in a fluid medium, either gas or liquid, it naturally tends to pivot about its longitudinal axis, also known as its roll axis, which axis is substantially coincident with the speed vector along the trajectory. This rotating movement is induced, when the missile is moving, by parasitic hydrodynamic or aerodynamic moments and/or thrust moments. These parasitic moments are due to constructional imperfections. The direction and magnitude of this rotational movement, or natural roll, are determined by the direction and magnitude of the resultant of the parasitic moments.

In certain missile firing applications, the roll attitude of the missile needs to be positionally controlled and held by servo-control in a given direction, for example when the missile is equipped with a homing-head or a military payload. In other applications it is desirable for the body of the missile to have imparted to it a rotary movement whose speed needs to be controlled within a more or less restricted range, for example with the object of enabling a detector carried by the missile to operate at a known scanning frequency.

Techniques for controlling the attitude of missiles are widely known, in particular those which use aerodynamic control surfaces derived from the control surfaces of aircraft. Mention may be made of ailerons carried by the wings and canard control surfaces positioned at the front of the fuselage. A very different technique uses the reaction forces resulting from the expulsion of gases. These various techniques give rise to problems when the missiles are employed operationally in applications which involve special conditions of storage, handling and launching, in particular when this latter operation is performed from within a cylindrical tube or by gun-barrel effect.

Accordingly the present invention consists in a missile including a system for controlling the roll attitude of the body of the missile, said system comprising a torque transmitter having a stator secured to the body adjacent the rear end thereof and a rotor connected to a finned empennage so that the empennage is rotatable about the longitudinal axis of said body, and roll attitude sensing means located in said body for sensing the roll attitude of said body and for supplying a control signal to said torque transmitter.

Some embodiments of the invention will now be described by way of example, with reference to the accompanying drawings, in which:—

Fig. 1 is a diagram which shows the basic principles of the invention,

Fig. 2 is a diagrammatic cross-section showing the application of the attitude controlling system to a roll-stabilised missile,

Fig. 3 shows a modified embodiment applied to a missile equipped with means of propulsion, and

Fig. 4 shows a modified embodiment applied to a missile equipped with jettisonable propulsion means.

In all the Figures, the same reference numerals indicate similar components.

Fig. 1 shows the elements of the invention in a simplified and schematic form. There can be seen the body 1 of a missile of which it is desired to control the roll attitude, and an empennage 2 which is able to rotate freely about the longitudinal axis of the missile body X. The connection between parts 1 and 2 is

provided by a torque motor 3 which consists of a rotor R and a stator S. Within the body are mounted the known elements of a servo-control means, namely roll attitude sensing means in the form of an attitude detector 4, an amplifier unit 5 and an electrical power supply 6.

The fins of the rotary empennage 2 are characterised by the angle α at which they are set, i.e. the angle which the plane of the fins makes with axis X, and by their angle of speed-back β, i.e. the angle which the edge of the fins makes with the perpendicular and with axis X, and also by their length and width. The angle α at which the wings are set is of a fixed value between zero and five degrees.

The method of operation is as follows: the missile is moving in a fluid in direction X when the attitude detector 4, which may be gyroscopic for example, detects that the body of the missile is rolling. It gives out an electrical signal proportional to the divergence measured. This divergence signal is amplified by the amplifier unit 5 and is applied to the rotor of the torque transmitter 3. The size of the restoring torque produced depends on the aerodynamic effectiveness of the fins on the relative speed of movement of the missile and on the amount of divergence from the correct attitude. When the fins are mounted on a pivot, they are able to be unfolded. The rotary empennage and the associated components form a means of servo-controlling position or speed, depending upon the desired application. In an example where speed is controlled, the attitude detector is a rate gyro. The torque transmitter may, inter alia, be a torque motor, an electromagnetic clutch, or an alternator. The stability of the servo-control means is determined by the transfer function of the components associated with the rotary empennage as a whole. It is well-known to those skilled in servo-mechanism how to obtain the characteristics of these components and more particularly those of the correcting electrical circuits inserted in the chain of control.

Fig. 2 is a sectional view of the system of the invention when applied to a roll-controlled missile. The rotary empennage and its torque transmitter are built into the base of the missile. The rotational independence between the body of the missile and the empennage is improved by using ball-bearings, which are not shown. The fins 7, which in practice are between 4 and 8 in number, are advantageously of the type which unfold when the missile is launched. The torque transmitter 3 is an electrical torque motor whose field circuit S is formed by a permanent magnet attached to the inside of the body of the missile. The rotor R connected to the rotary empennage receives the torque generating current via a brush-type collector. The components forming the associated parts of the servo-control means, such as the roll attitude detector, the amplifier unit and the source of electrical energy are located within the body of the missile. The auxiliary operations of starting, unlocking and uncaging the gyroscope are as currently employed during the launching phase of missiles.

Fig. 3 shows a modification of the previous application. The sectional view shows the application of the system of the invention to a missile equipped with propulsion means 10. The fins of the rotary empennage are situated at the point where the nozzle 11 of the propulsion means is situated. They may also be of the type which unfold on launching.

Fig. 4 shows a modified application of the invention in the case of a type of missile equipped with a jettisonable propulsion stage 20. The propulsion stage, which is secured to the rotary empennage of the missile stage proper, incorporates seatings 12 for the folding fins and an additional set of fins 13 situated near the nozzle 11.

When the missile is launched, the fins situated in the vicinity of the nozzle are unfolded and the fins of the missile stage are held captive by the propulsion stage. At the end of the combustion period, the propulsion stage is automatically jettisoned, thus freeing the fins of the missile stage.

The system of the invention has a number of positive advantages over known systems. In particular, it enables the roll of the body to be controlled using a single servo-control. The axial layout of the parts gives constructional strength, thus allowing launching by gun-barrel effect. The system is suitable for use with various different designs of missile, certain of which are illustrated by way of example in Figs. 2, 3, and 4.

It will be understood that the invention and its application to missiles has however been described and illustrated simply by way of example and that various modifications may be made without departing from the scope of the appended claims.

WHAT WE CLAIM IS:—

1. A missile including a system for controlling the roll attitude of the body of the missile, said system comprising a torque transmitter having a stator secured to the body adjacent the rear end thereof and a rotor connected to a finned empennage so that the empennage is rotatable about the longitudinal axis of said body, and roll attitude sensing means located in said body, for sensing the roll attitude of said body and for supplying a control signal to said torque transmitter.

2. A missile according to claim 1, in which the fins of said empennage form a zero angle with the longitudinal axis of said missile body.

3. A missile according to claim 1, in which the fins of said empennage are at an angle of not greater than 5° with respect to said longitudinal axis.

4. A missile according to any one of the preceding claims wherein the fins are recessed into the cylindrical part and are unfolded on launching the missile.

5. A system according to any preceding claim, wherein the torque transmitter is an electrical torque motor.

6. A missile according to any one of the preceding claims wherein the missile includes propulsion means.

7. A missile according to claim 6, wherein the propulsion means are jettisonable and include, at the point where the exhaust nozzle is situated, a set of fins which unfold when the missile is launched and wherein the fins of the empennage are arranged to unfold as a result of the propulsion means being jettisoned.

8. A missile substantially as hereinbefore described with reference to Fig. 1, or Fig. 2, or Fig. 3, or Fig. 4 of the accompanying drawings.

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2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 1

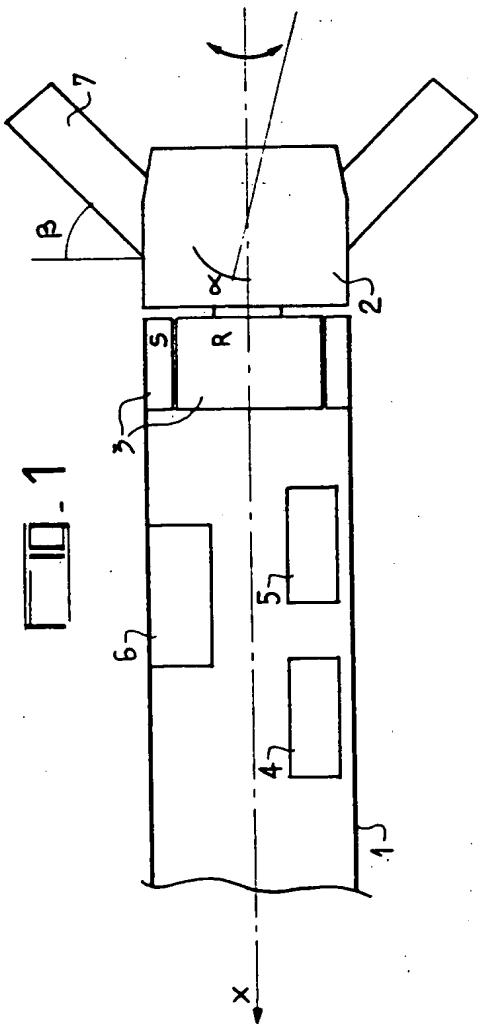

FIG. 1

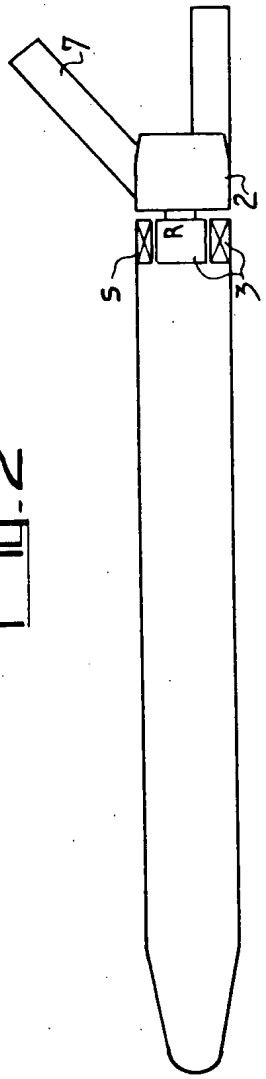

FIG. 2

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Sheet 2

FIG. 3

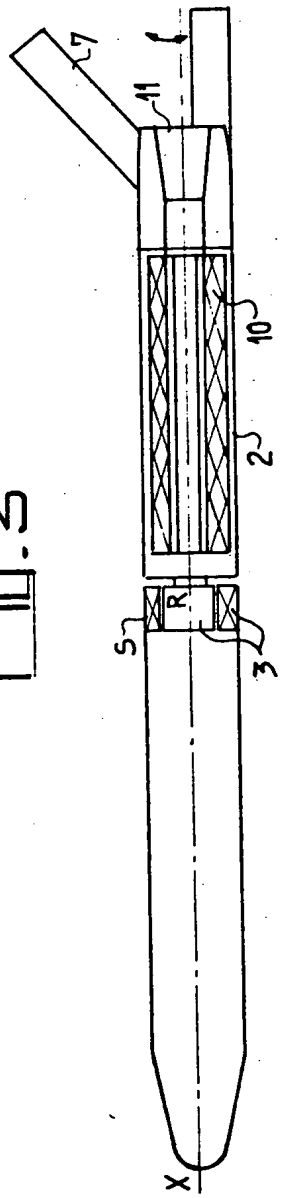

FIG. 4